Video signal transmission.

FIELD OF THE INVENTION

The invention relates to a method and an arrangement for transmitting video signals. The method comprises the steps of receiving an image of an original video signal, modifying an image area of said image to create a modified video signal, and transmitting the modified video signal. The invention also relates to methods and arrangements for receiving, decoding and transcoding such video signals.

BACKGROUND OF THE INVENTION

A method as defined in the opening paragraph is generally known and applied, inter alia, by television networks that modify an image area of an original video signal to include a visible logo. The logo identifies the broadcasting station or content owner. A useful property of the logo is that it remains visible after recording and thus assists in identifying illegal copies of home-recorded broadcast video material.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide a method of transmitting video signals, which renders further advantages and new applications possible.

To this end, the method in accordance with the invention includes the step of transmitting an auxiliary signal defining replacement video information for said image area of the modified video signal. Herewith it is achieved that receivers or transcoders can easily remove a logo or other mark which has been visibly attached to a video signal, replace said logo or mark by the replacement video information, and reproduce or retransmit the thus obtained video signal. Preferably, the replacement video information is the image area of the original signal. This allows the receivers or transcoders to undo the modification of the image and reconstruct the original video signal.

The invention allows television program providers to simultaneously transmit slightly different versions of a television program in an effective manner as one physical signal. Signal distributors located at head-ends of cable networks may select one of the versions for further distribution. For example, TV programs with a logo are distributed to first recipients, whereas the same content without the logo is distributed to other recipients.

Another example is the distribution of commercials with and without a public warning. Some countries require that such a warning be shown on screen if the advertised product is potentially dangerous to public health.

It is to be noted that a method of transmitting an original video signal and an auxiliary signal defining replacement video information for an image area thereof is known per se. For example, it is known to transmit a video signal along with subtitles accommodated in an auxiliary teletext data signal. Teletext receivers can display the subtitles, thereby replacing the original video information in an image area. The invention differs from this known method in that the main or "default" signal (which is understood to mean the signal which is reproduced by conventional receivers) is the modified signal. This renders it possible to assign a certain meaning to the signal modification, for example, an authorization to copy the video program, which is processed by all receivers, irrespective of whether or not they have provisions to undo the signal modification.

The invention is particularly useful if the original video signal is available in encoded form, for example, as an MPEG bitstream, and the modified signal is to be retransmitted in encoded form. In such an embodiment, in which the video signal is encoded into a channel bitstream and the image area is represented by a sub-series of bits, the replacement video information is preferably similarly encoded and represented by a substantially same number of bits as the modified image area. Stuffing bits may be inserted in either the modified signal or the auxiliary signal to achieve this. A receiver or transcoder can then simply replace the sub-series representing the sub-image by the auxiliary signal bits without any danger of causing buffer overflow or underflow problems in a subsequent decoder. The auxiliary signal is preferably accommodated in user data fields of the bitstream so that conventional (MPEG) decoders ignore this signal.

If the video signal is predictively encoded, the sub-images are advantageously accommodated in pictures which are not referred to by other pictures. For example, if the signal is encoded in accordance with the MPEG video compression standard, the sub-image is preferably accommodated in B-pictures only. This embodiment simplifies both the encoding and the decoding process considerably because the same I-pictures and P-pictures are used as reference, irrespective of whether the original or the modified video signal is to be (de-)coded.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a schematic diagram of an arrangement for transmitting video signals in accordance with the invention.

Fig. 2 shows the format of the output signal of the arrangement which is shown in Fig. 1.

Fig. 3 shows a schematic diagram of an arrangement for removing the mark and decoding or retransmitting the original video signal in accordance with the invention.

Fig. 4 shows a flow chart of operations that are performed by a control circuit which is shown in Fig. 3.

Figs. 5 and 6 show schematic diagrams of applications of the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Fig. 1 shows a schematic diagram of an arrangement for transmitting video signals in accordance with the invention. The arrangement receives an original video signal V_{org}, which is applied to a first input terminal of an input selection switch **10**, and a mark M, for example, a logo or a copy protection identifier, which is applied to a second input terminal of said switch. The selection switch **10** is controlled by a size and position control circuit **11** which determines the size and position of an image area in which the original video signal is to be replaced by the mark M. The selection switch **10** applies the selected video signal to a main MPEG encoder **12** to obtain an encoded modified signal V_{mod}.

The arrangement further comprises an auxiliary MPEG encoder **13** for encoding the original video signal image area, which is not included in the modified signal V_{mod}. In the Figure, this is achieved by a second selection switch **14**, which is also controlled by the size and position control circuit **11** and applies the original video signal V_{org} to the second encoder **13** when the first encoder **12** encodes the mark. The MPEG encoders **12** and **13** include a bit rate control circuit (not shown) so as to produce substantially the same number of bits for the mark and the original video signal image area.

The output of the second MPEG encoder **13** and data defining the size and position of the image area are multiplexed by a multiplexer **15** to form an encoded auxiliary video signal V_{aux}. The preferred embodiment of the arrangement further comprises a data embedding circuit **16** for accommodating the encoded auxiliary video signal V_{aux} in user data fields of the "main" MPEG bitstream representing the modified signal V_{mod}. Thus, if the composite output bitstream of the arrangement is applied to a conventional MPEG decoder (which ignores user data fields), only the modified video signal will be decoded and the video image with the mark will be reproduced.

The embodiment of the arrangement for transmitting video signals, which is shown in Fig. 1, receives the original video signal in the pixel domain. This is not necessary.

In Applicant's previously filed European patent applications 98400759.1 (PHF 98.544) and 98400802.9 (PHF 98.546) arrangements are proposed for inserting a logo in an already MPEG encoded video signal without requiring expensive full decoding of the bit stream. In accordance with this invention, the original bits of the macroblocks at the location of the logo are saved and added to the bit stream in the form of user data fields.

Fig. 2 shows the format of the output signal of the arrangement for transmitting video signals. The output signal comprises a sequence of encoded macroblocks **20** representing the original video signal. A subsequence of macroblocks **21** represents the image area containing the mark. Numeral **22** denotes a user data field USR which is accommodated in the bitstream. This field USR comprises a header **23** and a sequence of encoded macroblocks **24** representing the original video image part. More particularly, the header **23** includes:

- A start code SC to identify the start of a user data field. The MPEG standard provides the hexadecimal code 0000 01B2 for this purpose.
- A replacement identifier RI to identify that the user data field includes video replacement data.
- A number W2, which indicates the size of the user data field.
- A number W3 defining the address of the first macroblock of the image area.
- A number W4 indicating the length in bytes of the sequence of macroblocks, including stuffing bytes for alignment purposes.

Fig. 3 shows a schematic diagram of an arrangement for removing the mark from the modified signal in accordance with the invention. The arrangement receives the encoded composite video signal described above. The signal is applied to a control circuit **30**, a buffer **31**, and a first input terminal of a selection switch **32**. The buffer output is connected to the second input terminal of the selection switch. The control circuit **30** controls writing and reading of the buffer **31** through control lines RW. The circuit also controls the state of the selection switch **32** through a select line S.

The operation of the arrangement is defined by a sequence of operational steps that are performed by the control circuit **30**. Fig. 4 shows a flowchart of these operations. In a step **40**, the control circuit controls the selection switch **32** to select the first (S=1) input terminal. In this state of the switch, the macroblocks **20** (see Fig. 2) representing the original video signal outside the modified image area are directly applied to the output of the arrangement. In a step **41**, the control circuit checks the bitstream for the occurrence of the start code SC which identifies the start of a user data field. If the start code has been detected,

the control circuit reads the replacement identifier RI in a step **42** and checks whether RI identifies that the user data field contains video replacement data. If that is not the case, the circuit returns to the step **40** and awaits a next occurrence of the start code.

If RI identifies that the user data field contains video replacement data, the control circuit reads the numbers W2, W3 and W4 in a step **43**. Then, in a step **44**, the control circuit stores the macroblocks representing the original video contents of the image area (**24** in Fig. 2) in the buffer **30**. The number of bytes to be stored in the buffer is determined by W4. Note that the buffer is fairly small because the image area covers a few macroblocks only. During this operation of writing video data in the buffer, the control circuit may optionally fill the user data field in the output bitstream with arbitrary data. The user data field is not removed so as to guarantee that a subsequent decoder input buffer does not overflow or underflow.

In a step **45**, the control circuit detects the end of the user data field on the basis of the field size W2. The control circuit then continues in a step **46** in which it pass the received macroblocks to the output through the first (S=1) input terminal of the switch, until the first macroblock of the modified image area (**21** in Fig. 2) is received. To this end, the current macroblock address is compared with the start address of the image area as defined by the number W3 in a step **47**.

In a step **48**, the control circuit controls the selection switch **32** to select the second (S=2) input terminal so that the buffer contents is applied to the output. As a result thereof, the macroblocks representing the modified image area are replaced by the macroblocks representing the original video image. The number of bytes to be replaced is defined by W4. If all bytes have been read from the buffer (step **49**), the control circuit returns to the initial step **40** to pass the rest of the input stream (S=1) until a user data field with replacement video is found again.

The arrangement shown in Fig. 3 removes the mark from the modified video signal by simply replacing the macroblocks representing the modified image area by the replacement video macroblocks accommodated in user data fields. It will be appreciated that this simple replace operation is performed successfully if the MPEG decoder does not use the relevant macroblocks as reference for decoding other pictures. For this reason, the mark is preferably inserted in B-pictures only. Alternatively, the relevant macroblocks are autonomously (intra) encoded, irrespective of the picture type.

Fig. 5 shows a schematic diagram of an application of the invention. In this application, a video program with a logo is broadcast in a first reception area and the same

program without the logo is broadcast in a second environment. At the signal originating end, the system comprises an arrangement **50** which receives the original video signal and the logo. The arrangement **50** inserts the logo in the video signal in a manner as described before with reference to Fig. 1. That is, the output signal is an MPEG encoded version of the modified signal but also includes the original contents of the replaced image area as an auxiliary signal. The output signal is distributed to a first broadcast station **51** which broadcasts the signal without further processing. MPEG receivers receiving the signal from this station reproduce the video image with the logo. The signal from arrangement **50** is also distributed to a second broadcast station **51**. This station comprises an arrangement **53** for removing the logo as described above with reference to Fig. 3. The second station thus broadcasts the same program without the logo.

Another application of the invention relates to copy protection. In Applicant's previously filed European patent applications 97200165.5 (PHN 16.210) and 97201470.8 (PHN 16.372), a copy protection scheme has been proposed which allows video contents to be copied once. Such a copy once scheme allows television programs to be recorded for later reproduction (time shift), but prohibits the making of higher generation copies. In this scheme, two signals are used:

- An embedded watermark W to identify that the content is copy protected. The watermark can not be removed and indicates that the content may not be copied unless another mark T is present.
- The mark T (hereinafter referred to as ticket) which is added to the content and which is to be removed upon making a (first) copy.

Fig. 6 shows a schematic diagram of a system to illustrate an advantageous copy protection scheme. In an arrangement **60**, corresponding to the arrangement which is shown in Fig. 1, the ticket T is added to an original video signal V_{org} in the form of a particular modification of a given image area. The ticket is, for example, a particular pattern of high chrominance frequencies in a few of the lower or upper lines of the television image. Such a ticket survives analog as well as digital transmission, is visible but does not substantially disturb the image, and does not survive recording by conventional video recorders. A transmitter **61** broadcasts the modified signal as well as the auxiliary signal defining replacement video for the modified image area, in a format as described above with reference to Fig. 2.

The signal from transmitter **61** is received by a conventional receiving system comprising a tuner **62**, a conventional set top box (MPEG decoder) **63**, and a conventional

analog video recorder **64**. The MPEG decoder decodes the modified signal including the ticket and applies it to the video recorder in a conventional analog (RGB or YUV) signal format. Because the ticket contains high chrominance frequencies that are not recorded, the ticket is removed from the copy.

The signal from transmitter **61** is also received by a novel receiving system comprising a tuner **65**, a set top box **66**, and a digital versatile disc (DVD) recorder **67**. The novel set top box **66** comprises an arrangement **661** corresponding to the arrangement which is shown in Fig. 3. This arrangement removes the ticket T from the received signal and replaces it by the contents (preferably, the original video image area) accommodated in the user data field. As already described above with reference to Fig. 3, the size of the MPEG stream is not changed thereby, so that virtual buffer regulations are complied with. As the ticket information is no longer needed, and its presence even creates a security risk, the user data field is preferably filled with arbitrary data.

The signal processed by the arrangement **661** is then recorded on the DVD recorder **67**, either directly (if the recorder accepts the MPEG signal format) or via a conventional MPEG decoder **663**. The DVD recorder is of a type which records an applied signal only if it is accompanied by a record enable control signal RE. This signal is generated by a ticket detection circuit **663** and applied to the recorder through a secure communication link **68**, for example, an IEEE 1394 bus.

The system shown in Fig. 6 prohibits making next generation copies of recorded material. An MPEG encoded program recorded on DVD can be re-applied to the set top box **66** and reproduced through the MPEG decoder **663**. However, the program can not be recorded anymore because the ticket T has been removed. Similar considerations apply to the making of high quality (digital) copies of recordings made by the conventional video recorder **64**. Because the ticket is absent from on the first generation copy, digital copying on new equipment such as DVD recorder **67** is not possible.

In summary, the generation of an MPEG video stream is disclosed, which contains several slightly different programs, each with approximately the same content. The MPEG stream is constructed in such a manner that a simple transcoder can effectively select one of the programs. This is achieved by storing the differences relative to the default program in selected user data fields. The transcoder is little more than an MPEG bit stream parser, which replaces the bits corresponding to a selected set of macroblocks by the replacement data stored in the user data fields. A standard MPEG decoder without any knowledge of the embedded user data fields will simply extract the default program.